IN: Instrumentation Engineering

General Aptitude:

One Mark Questions(Q01–05)

01. The cost of 7 pens, 8 pencils and 3 sharpeners is Rs 20. The cost of 3 pencils, 4 sharpeners and 5 erasers is Rs 21. The cost of 4 pens, 4 sharpeners and 6 erasers is Rs 25. The cost of 1 pen, 1 pencil, 1 sharpener and 1 eraser is ________ (Rs)

Ans: 6

Sol: Let the costs of pens, pencil, eraser and sharpener be p_n, p_p, e and s respectively

Given

$7p_n + 8p_p + 3s = 20$

$3p_p + 4s + 5e = 21$

$4p_n + 4s + 6e = 25$

Adding all three equations

$11p_n + 11p_p + 11s + 11e = 66$

$\therefore 1p_n + 1\,p_p + 1s + 1e = 6$

02. **Sentence Completion:**

Although some think the terms "bug" and "insect" are -------, the former term actually refers to ------- group of insects.

(A) parallel - an identical

(B) precise - an exact

(C) interchangeable - particular

(D) exclusive - a separate.

Ans: (C)

Sol: The word "although" indicates that the two parts of the sentence contrast with each other: although most people think about the terms "bug" and "insect" one way, something else is actually true about the terms. Choice (C) logically completes the sentence, indicating that while most people think the terms are "interchangeable," the term "bug" actually refers to a "particular" group of insects.

03. **Sentence improvement:**

<u>Underestimating its value, breakfast is a meal many people skip.</u>

(A) Underestimating its value, breakfast is a meal many people skip

(B) Breakfast is skipped by many people because of their underestimating its value

(C) Many people, underestimating the value of breakfast, and skipping it.

(D) Many people skip breakfast because they underestimate its value.

Ans: (D)

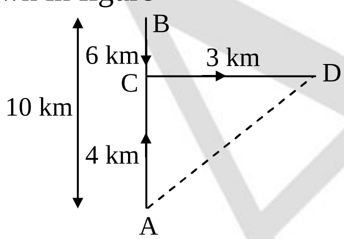
Sol: The problem with this sentence is that the opening phrase "underestimating its value" modifies "breakfast," not "people." The order of the words in the sentence in choice (D) does not have this problem of a misplaced modifying phrase. Choice (D) also clarifies the causal relationship between the two clauses in the sentence. None of the other choices convey the information presented in the sentence as effectively and directly as choice (D).

04. **Spot the error, if any:**
If I were her / I would accept / his offer
(A) If I were her (B) I would accept
(C) his offer (D) No error

Ans: (A)
Sol: Rule we should use Subjective case of pronoun after BE forms…am, is, are was were.,, has been, have been, had been.
Her is an objective case ---
If I were she. is correct

05. Kishenkant walks 10 kilometres towards North. From there, he walks 6 kilometres towards south. Then, he walks 3 kilometres towards east. How far and in which direction is he with reference to his starting point?
(A) 5 kilometres, West Direction
(B) 5 kilometres, North-East Direction
(C) 7 kilometres, East Direction
(D) 7 kilometres, West Direction

Ans: (B)
Sol: The movements of Kishenkant are as shown in figure



A to B, B to C and C to D
AC = (AB – BC) = (10 – 6) km = 4 km
Clearly, D is to the North-East of A
$\therefore$ Kishenkant's distance from starting point A

$$AD = \sqrt{AC^2 + CD^2}$$
$$= \sqrt{(4)^2 + (3)^2} = \sqrt{25} = 5 \text{ km}$$

So, Kishenkant is 5 km to the North-East of his starting point

Two Mark Questions(Q06–10)

06. The infinite sum $1+\frac{4}{7}+\frac{9}{7^2}+\frac{16}{7^3}+\frac{25}{7^4}+ - - - - -$ equals

Ans: 1.8 to 2

Sol: We have to find the sum of the series $1+\frac{4}{7}+\frac{9}{7^2}+\frac{16}{7^3}+\frac{25}{7^4}+ - - - - -$

Putting $x = \frac{1}{7}$ we get

$1 + 2^2x + 3^2x^2 + 4^2x^3 + 5^2x^4 + - - - - -$
$s = 1 + 4x + 9x^2 + 16x^3 + 25x^4$
$s.x = x + 4x^2 + 9x^3 + 16x^4 + - - - - -$
$s – sx = 1 + 3x + 5x^2 + 7x^3 + 9x^4 + - - - - - -$
$x(s – sx) = x + 3x^2 + 5x^3 + 7x^4 + - - - - - -$
$(s – sx) –x(s – sx) = 1 + 2x + 2x^2 + 2x^3 + - - - - - - + \text{to } \infty$

$$(1 – x)^2 s = 1+\frac{2x}{1-x};\ \text{since } |x|<1$$
$$s = \frac{1+x}{(1-x)^3}$$

We may use it as direct formula for solving this type of problem

Substituting $x = \frac{1}{7}$ we get

$$s = \frac{1+\frac{1}{7}}{\left(1-\frac{1}{7}\right)^3} = \frac{8\times 343}{7\times 216} = \frac{49}{27}$$

07. If $\frac{x}{3a+2b} = \frac{y}{3b+2c} = \frac{z}{3c+2a} = 5$ and a, b and c are in continued proportion and b, c, a are in continued proportion, then $\frac{x}{a}+\frac{y}{2b}+\frac{z}{3c}$ is _______ ($\because$ a, b and c are in continued proportion means $b^2 = ac$)

(A) $55\frac{1}{5}$ (B) 25

(C) $4\frac{1}{6}$ (D) $45\frac{5}{6}$

Ans: (D)

Sol: Given that a, b, c are in continued proportion $\Rightarrow b^2 = ac$ -------- (1)

Also b, c, a are in continued proportion

$\Rightarrow c^2 = ab$ ------- (2)

From (1) and (2)

$b^2c^2 = a^2bc \Rightarrow a^2 = bc$ ------- (3)

Conditions (1), (2) and (3) can only be satisfied when a = b = c = k (say)

$\therefore \frac{x}{5k} = \frac{y}{5k} = \frac{z}{5k} = 5 \Rightarrow \frac{x}{k} = \frac{y}{k} = \frac{z}{k} = 25$

$\therefore \frac{x}{a} + \frac{y}{2b} + \frac{z}{3c} = \frac{x}{k} + \frac{1}{2}\frac{y}{k} + \frac{1}{3}\frac{z}{k}$

$= 25 + \frac{25}{2} + \frac{25}{3}$

$= \frac{25 \times 11}{6} = \frac{275}{6} = 45\frac{5}{6}$

08. Rasputin was born in 3233 B.C. The year of birth of Nicholas when successively divided by 25, 21 and 23 leaves remainder of 2, 3 and 6 respectively. If the ages of Nicholas, Vladimir and Rasputin are in arithmetic progression, when was Vladimir born?

(A) 3227 B.C (B) 3229 B.C

(C) 3230 B.C (D) 3231 B.C

Ans: (C)

Solution: The year of birth of Nicholas

$$\begin{array}{ccc} 25 & 21 & 23 \\ \downarrow & \downarrow & \downarrow \\ 2 & 3 & 6 \end{array} \Rightarrow 3227$$

The ages of Nicholas, Vladimir and Rasputin are in A.P

The ages of Nicholas	Vladimir	Rasputin
3227	?	3233

$\therefore$ Vladimir age $= \frac{\text{Nicholas} + \text{Rasputin}}{2}$

$= \frac{3227 + 3233}{2} = 3230$ B.C

09. Recent studies have highlighted the harmful effects of additives in food (colors, preservatives, flavor enhancers etc.). There are no synthetic substances in the foods we produce at Munchon Foods - we use only natural ingredients. Hence you can be sure you are safeguarding your family's health when you buy our products, says Munchon Foods. Which of the following, if true, would most weaken the contention of Munchon Foods?

(A) Some synthetic substances are not harmful

(B) Some natural substances found in foods can be harmful

(C) Food without additives is unlikely to taste good

(D) Munchon Foods produces only breakfast cereals

Ans: (B)

Sol: Munchon's contention is that buying their products safeguards health. To weaken that argument we can show that, for some reason, their foods might not be healthy.

So think about an alternative cause

10. To open a lock, a key is taken out of a collection of n keys at random. If the lock is not opened with this key, it is put back into the collection and another key is tried. The process is repeated again and again. It is given that with only one key in the collection, the lock can be opened. The probability that the lock will open in 'n^{th}' trail is _____

(A) $\left(\frac{1}{n}\right)^n$ (B) $\left(\frac{n-1}{n}\right)^n$

(C) $1-\left(\frac{n-1}{n}\right)^n$ (D) $1-\left(\frac{1}{n}\right)^n$

Ans: (C)

Sol: Probability that the lock is opened in a trail is $\frac{1}{n}$ (since there is exactly one key, which opens the lock)

$\therefore$ The chance that the lock is not opened in a particular trail = $1-\frac{1}{n}$

P(lock is opened in n^{th} trial) = 1– P(lock is not opened in n trials)

$$= 1-\left[1-\frac{1}{n}\right]^n = 1-\left[\frac{n-1}{n}\right]^n$$

Technical Questions

One Mark Questions(Q11–35)

11. The number of minterms at the output of a 5-input exclusive OR gate is ____

Ans: 16

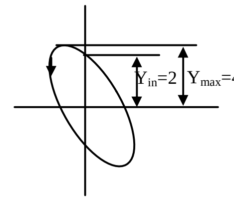
Sol: $\frac{2^5}{2}=\frac{32}{2}=16$ number of minterms.

12. A single channel Analog Cathode Ray Oscilloscope is operated in X-Y Display Mode. An ellipse with major axis in 2^{nd} and 4^{th} Quadrant and rotating in anti-clockwise direction displayed on the screen. The Y-intercept is at 2 div and Y_{max} is at 4 div. The phase difference(in degrees) between Vertical and Horizontal input signals is_______.

Ans: 330

Sol:

$$\phi = 360 - \sin^{-1}\left[\frac{Y_{in}}{Y_{max}}\right]$$
$$= 360 - \sin^{-1}(2/4)$$
$$= 360 - 30 = 330^o$$



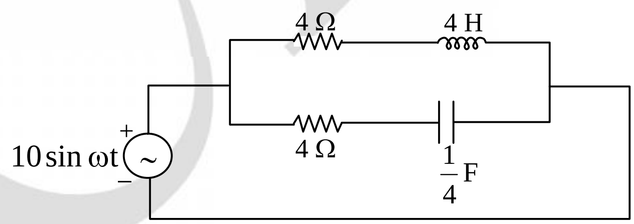
13. $\int_{-2}^{2}|1-x^4|dx =$

Ans: 12

Sol: $\int_{-2}^{2}|1-x^4|dx = 2\int_{0}^{2}|1-x^4|dx$ ($\because |1-x^4|$ is even function)

$$= 2\{\int_0^1(1-x^4)dx - \int_1^2(1-x^4)dx\}$$
$$= 12$$

14. Consider the following network.



The average true power dissipated in the circuit at resonance is _______ (in watts)

Ans: 12.5

Sol: Here $\frac{L}{C}=16=R^2$

$\Rightarrow \omega_0 = \frac{1}{\sqrt{LC}} = 1\,\text{rad/sec}$ and

$Z = R = 4\Omega = R_{eq}$

$I = \frac{V}{Z} = \frac{10\angle 0^o}{4} = \frac{5\angle 0^o}{2}$ A

$\Rightarrow I_{max} = \frac{5}{2}$ A`

$P_{avg} = I_{rms}^2\, R_{eq}$

$$\left(\frac{\frac{5}{2}}{\sqrt{2}}\right)^2 .4 = \frac{25}{4\times 2}\times 4 = 12.5\text{W}$$

15. A signal x[n] is having DFT X[k] which is given below:

$\{\boxed{x_0}, 3, -4, 0, 2\} \leftrightarrow \{5, \boxed{X_1}, -1.28 \boxed{-\ j}4.39, X_3\ , 8.78 - j1.4\}$

The value of x_0 is _____

Ans: 4

Sol: Using Conjugate symmetry

$X[k] = X^*[N - k]$ Here N = 5

$X[1] = X^*[4] = 8.78 + j1.4$

$X[3] = X^*[2] = -1.28 + j4.39$

$$x_0 = \frac{1}{N}\sum_{k=0}^{4} X[k] = 4$$

16. In the Op-amp circuit shown in figure terminal 'A' is grounded, terminal 'C' & 'E' are shorted and a common input signal V_i is applied at both the terminal 'B' & 'D'. If the output voltage, V_0 is obtained at terminal 'E' then $\frac{V_o}{V_i}$ will be ______

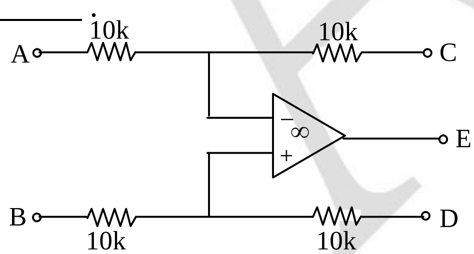
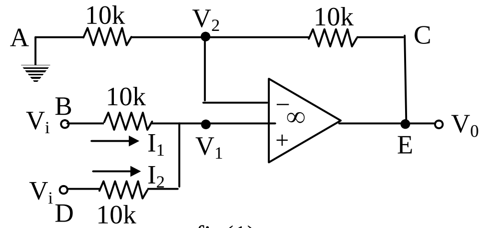


fig.

Ans: 2

Sol: As per the data given, the resultant circuit is shown in fig (1). i.e the resultant circuit is a two input closed loop non inverting amplifier



fig(1)

Step (1): KCL at V_1

$I_1 + I_2 = 0$ ------- (1)

$$\frac{V_i - V_1}{10k} + \frac{V_i - V_1}{10k} = 0 \text{ ------- (2)}$$

$2V_i - 2V_1 = 0$ ------ (3)

$V_1 = V_i$ ----- (4)

Step (2) :

$$V_o = \left[1 + \frac{R_f}{R_1}\right]V_1$$

$$= \left[1 + \frac{10k}{10k}\right]V_i = 2V_i \text{ ------- (5)}$$

$$\frac{V_o}{V_i} = 2 \text{ ------ (6)}$$

17. Consider the following networks

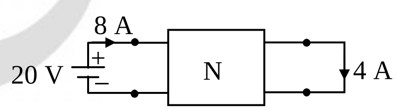


fig. (a)

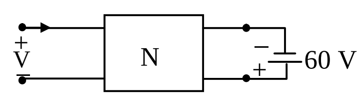


fig. (b)

The network 'N' contains only resistances. Use the data given in fig.(a) and find the voltage 'V' in fig.(b) _______ (in volts)

Ans: – 30

Sol: By Homogeneity, Reciprocity principles to figure (a) and by reversing the source polarities

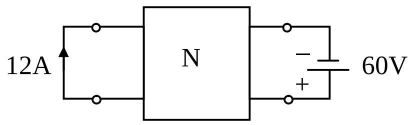


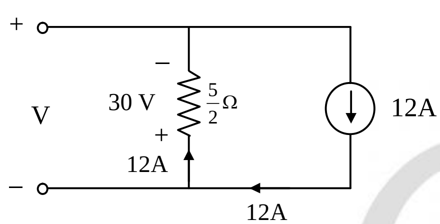
Figure. C

$\Rightarrow I_{SC}$ = 12A

From figure (a), R_{th} at port (1)

$\Rightarrow R_{th} = \frac{20}{8} = \frac{5}{2}\Omega$

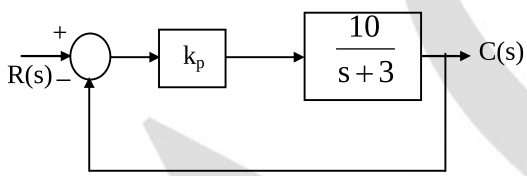
So, Norton's equivalent of figure (b)



By KVL $\Rightarrow$ V + 30 = 0

V = – 30V

18.



The value of K_P such that, the closed loop system time constant is one sixth of the open loop time constant is_____

Ans: 1.5

Sol: OLTF time constant is 1/3 sec

The CLTF time constant is $1/(3+10K_P)$

So,

$1/(3+10K_P) = (1/6)(1/3)$

$3+10K_P = 18$

$K_P = 3/2 = 1.5$

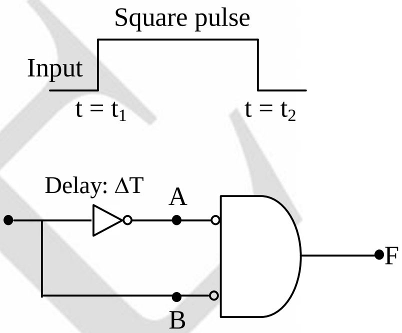
19. An accelerometer has a damping ratio of 0.7 The ratio of steady relative displacement to amplitude of input displacement for the value of frequency ratio 2.45 is_____.

Ans: 0.99

Sol: $\left|\frac{x_2 - x_1}{x_1}\right| = \frac{u^2}{\sqrt{(1-u^2)^2 + (2\xi u)^2}}$ where u = $\frac{\omega}{\omega_n} = \frac{f}{f_n}$ = 2.45, ξ = 0.7

= 0.99

20. Determine the function of the following circuit



(A) Negative Edge detector, which produces a Negative pulse of width ΔT

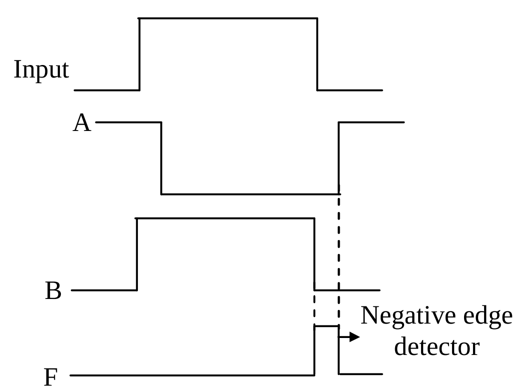
(B) It shift the input square pulse by ΔT

(C) It inverts the input pulse and shifts it by ΔT

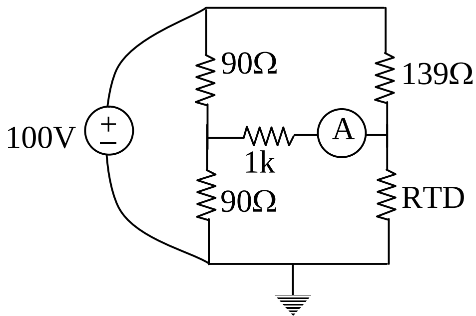
(D) It produces a positive pulse of width ΔT at $t = t_1$

Ans: (A)

Sol: It produces a pulse at Negative Edge of the input at $t = t_2$. It is a Negative edge detector.



21. A RTD having initial resistance of 100Ω is incorporated in a circuit as shown in figure.



If resistance temperature coefficient value of RTD is 0.0039/°C then the reading of Ammeter at 100°C is
(A): 13 mA
(B): 0 mA
(C): 10 mA
(D): 100 mA

Ans: (B)
Sol: At 100°C RTD resistance is 139Ω so bridge is balanced so current through the ammeter is 0A. Option (b) is correct.

22. In the following program "DCX B" Instruction doesn't affect the flags, then which of the following logic is used to check whether the BC value has become 0000H or not.

```
        LXI B, 0005H
LOOP:   DCX B
        --------
        ---------
        JNZ   LOOP.
```

(A) MOV A,C
CMP B

(B) MOV A,C
SUB B

(C) MOV A, B
ORA C

(D) MOV A, B
ANA C

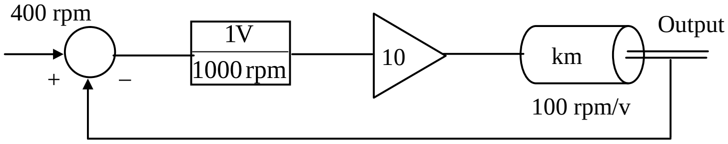
Ans: (C)
Sol: 'DCX B' doesn't affect flags, hence 'B' value is stored in A register and 'OR' ed with 'C' register.

23. Consider the following statements
(A) Inductor and capacitor stores energy only for A.C. excitations
(B) In source free circuits the energy is maximum in steady state
(C) Tellegen's theorem is valid only for linear networks
(D) For RL-impedance function, poles and zeros are alternate and lies only on the negative real axis and nearest to the origin is zero.

Which of the above statements are/is true
(A): a and
(B): b and c
(C): c and d
(D): only d

Ans: (D)
Sol:
(A) Inductor and capacitor will store Energy for all the time varying excitations including d.c during the transient period
(B) In source free circuit energy is zero during the steady state, provided τ is finite.
(C) No limitations on the circuit elements for applying the Tellegen's theorem
(D) RL - impedance function must have alternate poles and zeros on negative real axis and nearest to the origin is the zero.

24. For the process figure shown the output of the DC motor is



(A) 200rpm (B) 300 rpm
(C) 100 rpm (D) 400 rpm

Ans: (A)

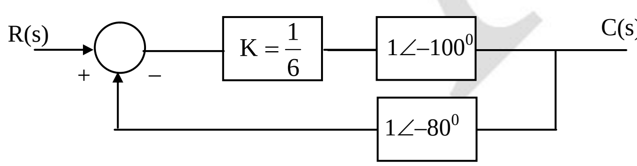
Sol: C(t) = $\left(\frac{1}{1+1}\right)400\,\text{rpm}$ = 200 rpm

25. The negative feedback systems performance at lower frequencies indicate
(A) Stability
(B) Noise performance
(C) Steady state
(D) All of the above

Ans: (C)

Sol: At low frequency zone, low frequency corresponds to time being large. It indicates steady state behaviour of the system. The lower frequency range indicates steady state error behaviour. Lag compensator works to reduce steady state error as it has pole at lower frequencies.

26. For Block diagram shown in figure the Zigler nichols setting for proportional Controller is



(A) 2.7 (B) 3.6
(C) 3 (D) 6

Ans: (C)

Sol: For the Block Diagram ultimum gain K_u = 6. So, Zigler nichols setting for propotional controller is 0.5×6 = 3

27. If $X_r = \cos\left(\frac{\pi}{3^r}\right) + i\sin\left(\frac{\pi}{3^r}\right)$ for r = 1, 2, 3, ... Then $X_1 . X_2 . X_3$ .... (upto infinity) equal to
(Where, i = $\sqrt{-1}$)
(A) –1 (B) 1
(C) I (D) $\frac{1}{2} + i\frac{\sqrt{3}}{2}$

Ans: (C)

Sol: $X_r = \cos\left(\frac{\pi}{3^r}\right) + \sin\left(\frac{\pi}{3^r}\right) = e^{i\left(\frac{\pi}{3^r}\right)}$, r = 1, 2, 3, ...

$X_1 . X_2 . X_3 ......\quad e^{i\pi\left(\frac{1}{3}+\frac{1}{3^2}+\frac{1}{3^3}+.....\right)} = e^{\frac{i\pi}{2}} = i$

28. The Routhian array of the system is given below. Identify the true statement corresponding to the system.

S^3	1	1
S^2	4	4

(A) Two roots are at S = ± j1
(B) No roots are in RHP (Right Half of S-plane)
(C) One root in LHP
(D) All of the above

Ans: (D)

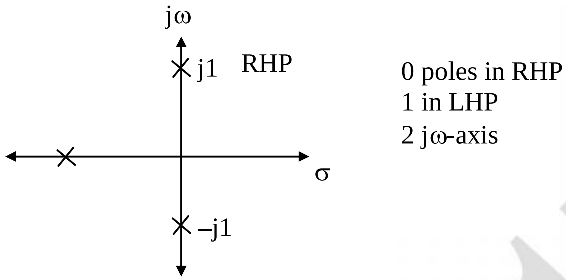
Sol:

s^3	1	1
s^2	$4s^2$	$4s^0$
~~s^1~~	~~0^2~~	~~0^0~~ → One time row of zeros
s^0	1	0

$AE = 4s^2 + 4$
$= s^2 + 1$

$\frac{d(AE)}{ds} = 2s$

So, the C.E roots are located as shown below



29. If the probability of hitting a target is $\frac{1}{5}$ and if 10 shots are fired, what is the conditional probability that the target being hit atleast twice assuming that atleast one hit is already scored?
(A) 0.6999 (B) 0.624
(C) 0.892 (D) 0.268

Ans: (A)

Sol: $P(x \geq 2 | x \geq 1) = \frac{P(x \geq 2)}{P(x \geq 1)}$

$= \frac{1 - q^n - npq^{n-1}}{1 - q^n}$

$= \frac{1 - \left(\frac{4}{5}\right)^{10} - 10\left(\frac{1}{5}\right)\left(\frac{4}{5}\right)^9}{1 - \left(\frac{4}{5}\right)^{10}}$

$= 0.6999$

30. An input signal $x(n) = (0.5)^n u(n)$ produces the output as $y(n) = \delta[n] - 2\delta[n-1]$. Then the nature of the transfer function is _____
(A) FIR and linear phase
(B) FIR but not having linear phase
(C) IIR and linear phase
(D) IIR but not having linear phase

Ans: (A)

Sol: $H(z) = \frac{Y(z)}{X(z)}$

$= \frac{1 - 2z^{-1}}{1/1 - 0.5z^{-1}} = 1 - 2.5z^{-1} + z^{-2}$

$h[n] = \delta[n] - 2.5\,\delta[n-1] + \delta[n-2]$

h[n] even symmetric about its midpoint

∴ FIR & linear phase

31. For which value of α the following system of equations is inconsistent?
$3x + 2y + z = 10$
$2x + 3y + 2z = 10$
$x + 2y + \alpha z = 10$
(A) $\frac{7}{5}$ (B) $\frac{-7}{5}$
(C) $\frac{-5}{7}$ (D) $\frac{5}{7}$

Ans: (A)

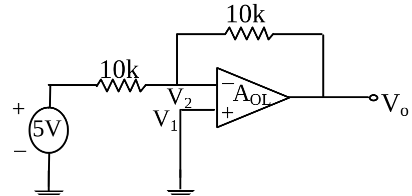
Sol: $\begin{vmatrix} 3 & 2 & 1 \\ 2 & 3 & 2 \\ 1 & 2 & \alpha \end{vmatrix} = 0$

$\Rightarrow 3(3\alpha - 4) - 2(2\alpha - 2) + (4 - 3) = 0$

$\Rightarrow 5\alpha - 7 = 0$

$\therefore \alpha = \frac{7}{5}$

32. In the Op-amp circuit shown in figure, if the Op-amp has an open loop gain of 10, infinite input resistance and zero output resistance then output voltage V_o is



fig

(A) – 5V (B) 10V
(C) – 4.166V (D) 4.166V

Ans: (C)

Sol: Step(1):

The general formula for output voltage in an op-Amp circuit is

$V_o = A_{OL}V_{id} = A_{OL}(V_1 - V_2) = 10(0 - V_2)$

$= -10\ V_2$ -------- (1)

At $V_2 = -\frac{-V_o}{10}$ -------- (2)

Step (2):

KCL at node V_2:

$\frac{5V - V_2}{10K} + \frac{V_o - V_2}{10K} = 0$ -------- (3)

$5V - V_2 + V_o - V_2 = 0$ ------- (4)

$5V + \frac{V_o}{10} + V_o + \frac{V_o}{10} = 0$ ------- (5)

$V_o\left[\frac{1+10+1}{10}\right] = -5V$ ------- (6)

$V_o = -5V \times \frac{10}{12} = -4.1666V$ ------ (7)

33. In forward biased photodiode, with increase in Incident light intensity, the diode current will
(A) Increases
(B) Remains constant
(C) Decreases
(D) Remains constant, but the voltage drop across the diode increases

Ans: (A)

Sol: In forward bias diode acts like ordinary pn-junciton diode

$I_D = I_0\left[e^{\frac{qV_D}{\eta KT}} - 1\right]$. In forward bias majority carriers also support the conductivity. So overall current increases but the increases is small.

34. Which of the following can be the eigen signal of an LTI system?
(A) $e^{-2t}\,u(t)$ (B) e^{-j2t}
(C) cos2t (D) sin4t + cos8t

Ans: (B)

Sol: If the input to a system is its eigen signal, the response has the same form as the eigen signal

35. The best resolution of Three and half digit digital multimeter is______. The operating Voltage Ranges are: 0-2V,0-20V,0-200V.
(A) 2Mv (B) 1mV
(C) 3 mV (D) 0.5mV

Ans: (B)

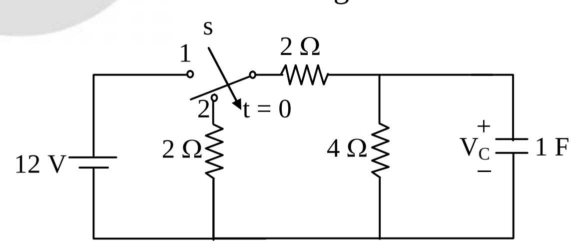
Sol: For $3\frac{1}{2}$

$R = \frac{1}{10^N} = \frac{1}{10^3} = 1\text{mV}$

N = No. Of full digits

Two Marks Questions(Q36–65)

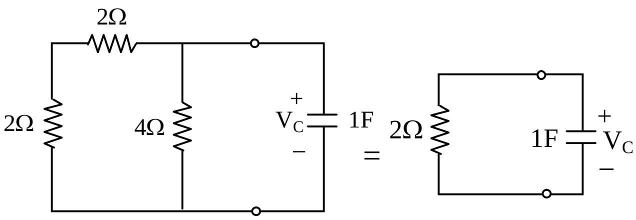
36. Consider the following network



The switch is in position '1' for a long time and it is moved to position '2' at t = 0. Determine the time 't' at which 75 % of the stored energy to be delivered by the capacitor to resistors _____ (in sec)

Ans: 1.2 to 1.5

Sol: $V_C(0^-) = \left(\frac{12}{2+4}\right).4V = 8V = V_C(0^+)$



for $t \ge 0$

$\tau = R_{eq}.C = (4//4).1 = 2sec$

$V_C(t) = V_0\, e^{-t/\tau} = 8e^{-t/2}(V)$ for $0 \le t \le \infty$

$E_C(t) = \frac{1}{2}.C.V_C^2(t) = \frac{1}{2}.1.\left(8e^{-t/2}\right)^2$

$= 32.\, e^{-t}$ (J) for $0 \le t \le \infty$

$\Rightarrow \tau_E = 1sec$

Let at $t = t_1$, 75% of the stored energy to be delivered by the capacitor to Resistors

$\Rightarrow$ 25% of the initial stored energy remined in the capacitor

$\Rightarrow E_C(t_1) = E_{C0}.\, e^{\frac{-t_1}{\tau_E}}$

$\Rightarrow$ 25% of $E_{C0} = E_{C0}.\, e^{\frac{-t_1}{\tau_E}}$

$\Rightarrow \frac{25}{100}.E_{C0} = E_{C0}.\, e^{\frac{-t_1}{\tau_E}}$

$\Rightarrow e^{\frac{t_1}{\tau_E}} = \frac{100}{25} = 4$

$\Rightarrow t_1 = \tau_E \ln 4 = 1\times \log_e 4$ sec

$\Rightarrow t_1 = 1.386$ sec

37. Let $x[n] = h[n] = \{2,6,0,4\}$. If $g[n] = x[n/2] * h[n/2]$ assuming zero interpolation the value of g(n) at n =2 is ______

Ans: 24

Sol:

$x(n/2) \rightarrow 2\ 0\ 6\ 0\ 0\ 0\ 4\ 0$

$h(n/2) \rightarrow 2\ 0\ 6\ 0\ 0\ 0\ 4\ 0$

Using sum by column method

g(n) = {4, 0, 24, 0, 36, 0, 16, 0, 48, 0, 0, 0, 16, 0, 0, 0}

g(2) = 24

38. Given the differential equation $y^1 = x - y$ with initial condition $y(0) = 0$. The value of $y(0.1)$ calculated numerically upto the third place of decimal by the 2nd order Runge-Kutta method with step size h = 0.1 is............

Ans: 0.005

Sol: Given $y^1 = x - y$

Also given $y(0) = 0$ and $h = 0.1$

$y(0.1) = ?$

Let $x_0 = 0$, $x_1 = x_0 + 1.h = 0 + 0.1 = 0.1$

The 2nd order Runge-Kulta method is given by

$y_1 = y(x_1) = y_0 + \frac{1}{2}(k_1 + k_2)$

where $k_1 = h\, f(x_0, y_0)$ and

$k_2 = h\, f(x_0 + h,\ y_0 + k_1)$

$k_1 = (0.1)\,[x_0 - y_0] = (0.1)\,(0 - 0) = 0$

$k_2 = (0.1)\,[(x_0 + h) - (y_0 + k_1)]$

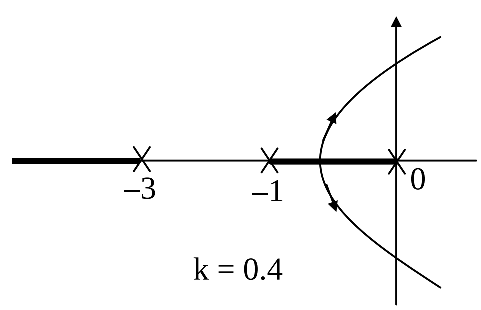
$= (0.1)\,[0 + 0.1 - (0 + 0)] = 0.01$

$y_1 = y(0.1) = 0 + \frac{1}{2}(0 + 0.01)$

$= \frac{0.01}{2}$

$= 0.005$

39. The gain margin of the system for $K_{operating} = 0.4$ is -------



Ans: 30

Sol:

$$C.E \Rightarrow s^3 + 4s^2 + 3s + k = 0$$

s^3	1	3
s^2	4	k
s^1	$\frac{12-k}{4}$	0
s^0	k	

$k_{mar} = 12$

$$GM = \frac{k_{mar}}{k_{operating}} = \frac{12}{0.4} = 30$$

40. Consider a digital message having a data rate of 8kbps and average energy per bit 0.01 (unit). If this message is transmitted using QPSK modulation (having initial phase of carrier as π/4) then minimum separation distance in signal space is —— (units).

Ans: 0.2

Sol: Minimum distance in signal space for QPSK having an initial phase of 45° with carrier $= 2\sqrt{E_b}$ = 0.2 (units)

41. A classical biasing arrangement for a silicon transistor having V_{BE} = 0.7V and β = 100 is shown in figure, the value of V_{Th} required to establish a voltage drop of $\frac{V_{CC}}{3}$ across R_E with the $\frac{R_{Th}}{R_E}$ resistance ratio of 5.73 is [When V_{Th} & R_{Th} are Thevenin equivalent voltage & Resistance at Base node of BJT in the given circuit] _______ (Volts)

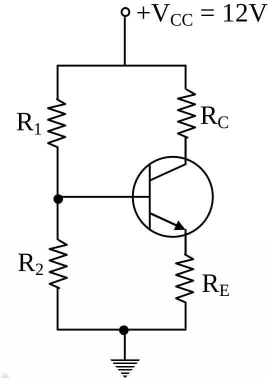


fig.

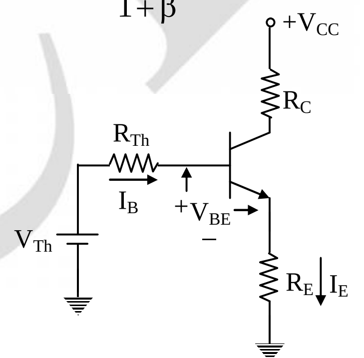
Ans: 4.8 to 5.0

Sol: Step(1):

KVL for the input loop of circuit shown in fig(a)

$$V_{Th} - I_B R_{Th} - V_{BE} - I_E R_E = 0 \text{ ------- (1)}$$

$$I_E = \frac{V_{Th} - V_{BE}}{R_E + \frac{R_{Th}}{1+\beta}} \text{ ---- (2)} \quad [\because I_B = \frac{I_E}{1+\beta}]$$



fig(a): Thevenin equivalent as the given circuit

$$V_{Th} = \frac{V_{CC} R_2}{R_1 + R_2}$$

$R_{Th} = R_1 // R_2$

Step (2):

$$\text{But } I_E R_E = \frac{V_{CC}}{3} = \left[\frac{V_{Th} - V_{BE}}{R_E + \frac{R_{Th}}{1+\beta}}\right] R_E \text{ ----- (3)}$$

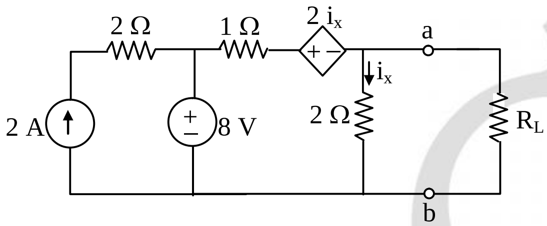
(∴ Given that voltage drop across $R_E = \frac{V_{CC}}{3}$)

$$\left\{\frac{(V_{Th}-V_{BE})}{R_E\left[1+\left(\frac{R_{Th}}{R_E}\right)\left(\frac{1}{1+\beta}\right)\right]}\right\}R_E=\frac{V_{CC}}{3} \text{ ----- } (4)$$

$$V_{Th} = \frac{V_{CC}}{3}\left[1+5.73\times\frac{1}{101}\right]+V_{BE} \text{ ----- } (5)$$

V_{Th} = 4.92693V -------- (6)

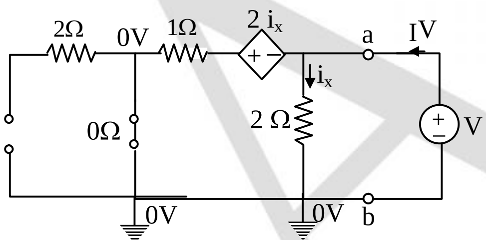
42. Consider the following network



The Thevenin's equivalent resistance seen from the load terminals a, b is ______ (in Ω)

Ans: 0.4

Sol: Evaluation of R_{Th} by case (3) approach



$$\text{Nodal} \Rightarrow \frac{V+2i_x}{1}+\frac{V}{2}-I=0$$

$$\Rightarrow I = \frac{3V}{2}+2i_x \quad \text{--------(1)}$$

$$i_x = \left(\frac{V-0}{2}\right)A \quad \text{--------(2)}$$

Equation (2) in (1)

$$\Rightarrow I = \frac{3V}{2}+V$$

$$I = \frac{5V}{2}$$

$$\frac{V}{I} = R_{Th} = R_N = \frac{2}{5}\Omega = 0.4\,\Omega$$

43. A fair coin is tossed until one of the two sides occurs twice in a row. The probability that the number of tosses required is even is ________.

Ans: 0.66 to 0.67

Sol: A = {HH, HTHH, HTHTHH, ...}

B = {TT, THTT, THTHTT, ...}

$P(A) = \frac{1}{3}$ & $P(B) = \frac{1}{3}$

$P(A \text{ or } B) = \frac{2}{3}$

44. The inductance of a moving iron instrument is given by L = $(10 + 5\theta - \theta^2)$ μH, where θ is the deflection in radius from zero position. The spring constant is 12×10^{-6} N-m/rad. The deflection of the instrument for a current of 5A is __________ (in radian)

Ans: 1.6 to 1.7

Sol:
$$\theta = \frac{\frac{1}{2}I^2\frac{dL}{d\theta}}{K_C} = \frac{\frac{1}{2}(5)^2\frac{d}{d\theta}\left(10+5\theta-\theta^2\right)}{12\times10^{-6}}$$

θ = 1.69 rad

45. The Quantum efficiency of a particular silicon APD is 80% for the detection of radiation at a wavelength of 0.9 μm. When the incident optical power is 0.5 μW, the output current from the device (after avalanche gain) is 11μA. The multiplication factor of the photodiode under these conditions is ____.

Ans: 37 to 38

Sol: Quantum efficiency (Q) = $\dfrac{r_{eHP}}{r_{PH}} = \dfrac{\dfrac{I_{PH}}{q}}{\dfrac{p_0}{(E_{PH})}}$

$$= \frac{I_{PH}}{q}\times\frac{E_{PH}}{p_0} = \frac{E_{PH}}{q}\times R_e$$

$$Q = \frac{E_{PH}}{q}\times R_e \Rightarrow R_e = \frac{I_{PH}}{p_0}$$

R_e = 0.581 A/W $\qquad I_{PH}$ = 0.581 A/W $\times 0.5\times10^{-8}$ = 0.291 μA

But $I_{APD} = M.I_{PH}$

M = 37.8

46. In the amplifier circuit shown in figure, a silicon transistor with h_{ie} = 2.5 kΩ and h_{fe} = 100 is used. The value of Emitter bypass capacitor, C_E required to establish the lower 3-dB frequency at 100Hz is ____ μF.

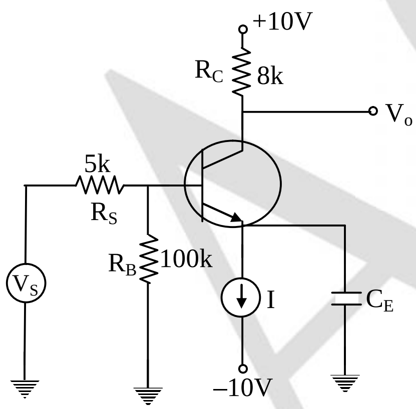


fig.

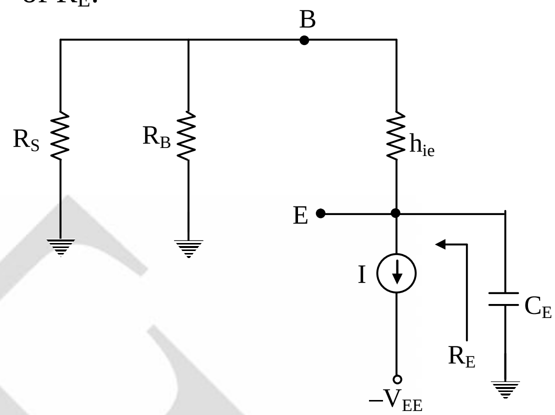
Ans: 22.14463 (22.00 to 23.00)

Sol: General formula for Lower 3dB frequency with reference to emitter bypass capacitor, C_E is

$$f_L = \frac{1}{2\pi R_E C_E} \text{ ------ (1)}$$

That means, for the estimation of C_E, the equivalent resistance at emitter section (R_E) of the given amplifier is required

Step (1): Equivalent Circuit for the estimation of R_E:



$I = I_E = (1+h_{fe})I_B$

$$R_E = \frac{h_{ie}}{1+h_{fe}} + \frac{R_S // R_B}{1+h_{fe}} \text{ -------- (2)}$$

$$= \frac{2.5k}{101} + \frac{5k//100k}{101} \text{ -------- (3)}$$

= 71.89757 Ω ------- (4)

Step (2):

Estimation of C_E :

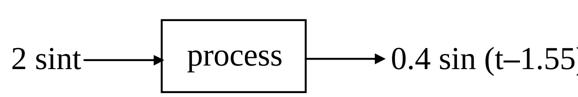
Consider $f_L = \dfrac{1}{2\pi R_E C_E}$ -------- (5)

$$\Rightarrow C_E = \frac{1}{2\pi R_E f_L}$$

$$= \frac{1}{2\pi\times 71.89757\Omega\times100\text{Hz}} \text{ -------- (6)}$$

C_E = 22.14463 μF --------- (7)

47. The process control has input and output as shown below. Then the gain and phase shift provided by this process is.



(A) 0.2, -89° (B) 0.4, -89°
(C) 0.2, -1.55° (D) 0.4, -1.55°

Ans: (A)

Sol: Gain of the system is the ratio of magnitude of o/p to that of i/p.

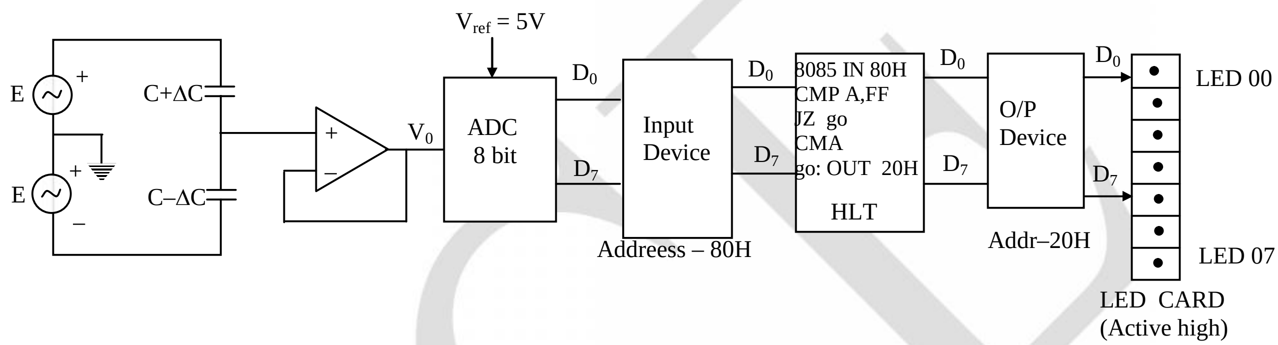
Output = M_{sys} [2] sin (t + ϕ_{sys} + $\phi_{i/p}$)

$M_{sys}(2) = 0.4$ $M_{sys} = 0.2$= gain

$$\phi_{sys} = -1.55 \times \frac{180}{\pi} = -89^{\circ}$$

48. If the capacitive Transducer has 5% error. according to the 8085 program what is the correct LED pattern?

(A) FAH B) AAH
(C) FFH D) 00H



(A) FAH B) AAH
(C) FFH` D) 00H

Ans: (C)

Sol: $V_0 = E.\dfrac{\Delta C}{C} = (100)\,(0.05) = 5V$

ADC O/P = FF [as full scale **]**

According to program:
ZF = 1, so jump to go: 'A' = FF will be transfer to 20H port. At that all LED's will be 'ON'. So, "FFH".

49. Let M be the matrix $\begin{bmatrix} 2 & 3 \\ 1 & -1 \end{bmatrix}$. Which of the following matrix equations does M satisfy.

(A) $M^3 + 3M + 5I = 0$
(B) $M^3 - M^2 - 5M = 0$
(C) $M^3 - 3M^2 + M = 0$
(D) $M^2 - M + 5I = 0$

Ans: (B)

Sol: The characteristic equation is $\lambda^2 - \lambda - 5 = 0$. we have $M^2 - M - 5I = 0$ (using cayley Hamilton theorem)

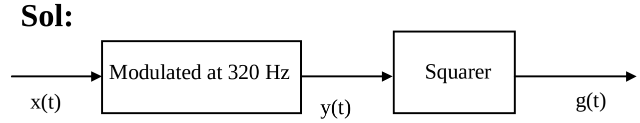
Multiplying both sides by M.
we get, $M^3 - M^2 - 5M = 0$

50. A signal x(t) is band-limited to 40 Hz and modulated by a 320 Hz carrier to generate the modulated signal y(t). The modulated signal is processed by a square law device to produce $g(t) = y^2(t)$. The minimum sampling rate required for g(t) to prevent aliasing is _____

(A) $f_s > 80$ Hz
(B) $f_s > 1440$ Hz
(C) $180 < f_s < 186.67$ Hz
(D) $360 < f_s < 373.33$ Hz

Ans: (D)

Sol:



Since y(t) is a band pass signal, f_L = 280 Hz & f_H = 360 Hz

Largest integer K

$$= \frac{f_H}{f_H - f_L} = \frac{360}{360 - 280} = 4$$

For minimum f_s we require

$$\frac{2f_H}{K} < f_s < \frac{2f_L}{K-1}$$

$180 < f_s < 186.67$ Hz

Since g(t) is a band pass signal f_L = 560 Hz & f_H = 720 Hz

For minimum f_s, we require

$$360 < f_s < 373.33 \text{ Hz for g(t)}$$

51. In the amplifier circuit shown in figure, a silicon transistor with h_{fe} = 100, h_{ie} = 1K, $h_{re} = h_{oe} = 0$ is used. Assume the inverting amplifier has infinite input resistance and zero output resistance, with $A = A_v = -1000$. If a negative feedback of feedback factor $\beta = \frac{1}{100}$ is implemented as shown, the value of $\frac{V_0}{V_s}$ approximately is

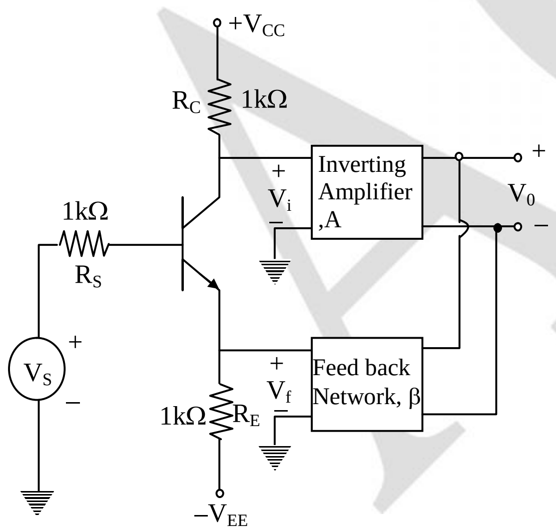


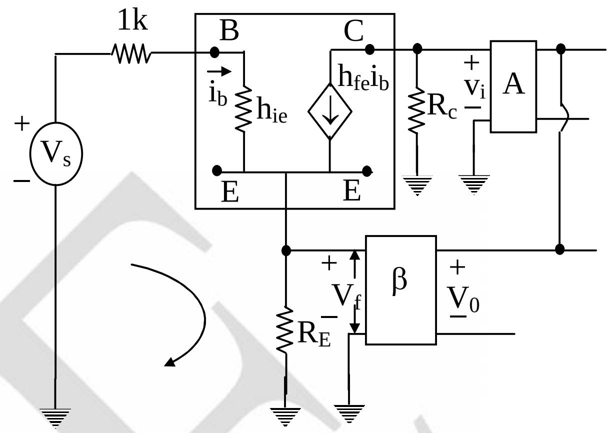
fig.

(A) 99.8 (B) – 99.8

(C) – 1000 (D) 11000

Ans: (A)

Sol:



fig(a).

Small signal model of the given amplifier

Step (1):

From the small signal model shown in fig(a)

$V_i = -h_{fe} i_b R_C$ --------- (1)

$= -100 \times 1k\Omega \ i_b$ ---------- (2)

$V_o = AV_i$

$= 1000 \times 100 \times 1k\ \Omega\ i_b$ --------- (3)

$V_f = \beta V_o = \beta A V_i$ -------- (4)

$= \frac{1}{100} \times 1000 \times 100 \times 1k\Omega\ i_b$ --- (5)

$= 1000 \times 1k\Omega\ i_b$ --------- (6)

Step (2):

KVL for input loop

$V_s = i_b [R_s + h_{ie}] + V_f$ ---------- (7)

$= i_b [R_s + h_{ie} + 1000 \times 1k\Omega]$ --- (8)

$= i_b [2k\Omega + 1000k\Omega]$ --- (9)

Step (3):

$$\frac{V_0}{V_s} = \frac{1000 \times 100 \times 1k\Omega\, i_b}{1002\, k\Omega\ i_b}$$

= 99.8 --------- (10)

52. The D/A converter of a counter type ADC has a step size of 10mV. The ADC has 10-bit resolution and have a Quantization

error of $\pm\frac{LSB}{2}$. Determine the digital output for an analog input of 4.012V.

(A) 191H (B) 192H
(C) 190H (D) 004H

Ans: (A)

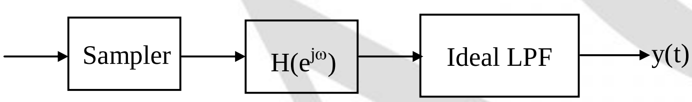
Sol: →Quantization error = $\pm\frac{LSB}{2} = \pm\frac{10}{2} = \pm 5$mV

→ In counter type ADC, When V_{in} = 4.012V, the other input of comparator need to be 4.012V. i.e. The DAC output has to be 4.012 –0.005 = 4.007mV

→ Number of steps = $\frac{4.007}{10\times10^{-3}}$ = 400.7 ≈ 401.

→ ADC output is ⇒ $(0\ 1\ 1\ 0\ 0\ 1\ 0\ 0\ 0\ 1)_2$ = 191H

53. An analog signal $x(t) = \cos(0.25\pi t)$ is passed through the following system.



The sampler is ideal and operates at f_s = 1Hz. The cut-off frequency of the ideal low pass filter is f_c = 0.5 Hz. The transfer function of the digital filter is $H(e^{j\omega}) = \text{rect}(\omega/\pi)e^{-j\omega/4}$. The relation between y(t) and x(t) is _____

(A) y(t) = x(t)
(B) y(t) = x(t –0.25)
(C) y(t) = x(t – 0.5)
(D) y(t) = x(t + 0.5)

Ans: (B)

Sol: $x(t) = \cos\left(\frac{\pi t}{4}\right)$ with f_s = 1Hz,

$x(n) = \cos\left(\frac{\pi n}{4}\right)$, $\omega_0 = \frac{\pi}{4}$

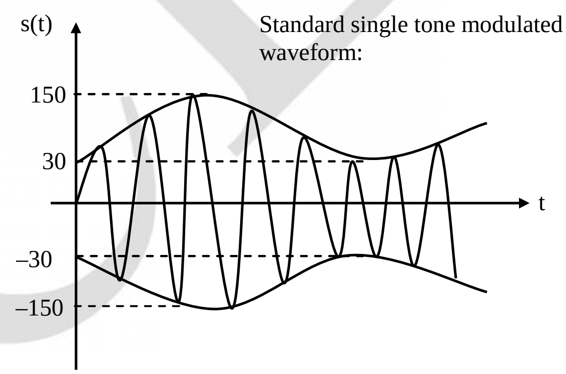
$H(e^{j\omega_0}) = e^{-j\pi/16}$ Thus,

$y(n) = \cos\left(\frac{n\pi}{4} - \frac{\pi}{16}\right)$

$\therefore y(t) = \cos\left(\frac{\pi t}{4} - \frac{\pi}{16}\right)$

$= \cos\left(\frac{\pi}{4}(t - 0.25)\right) = x(t - 0.25)$

54. An AM modulated waveform in time domain is shown in the figure below:



Determine the amplitude and phase of the additional carrier which must be added to the above waveform so as to have a 80% modulated waveform [i.e. modulation index = 0.8].

(A): 15∠0° (B): 15∠180°
(C): 115∠0° (D): 115∠180°

Ans: (B)

Sol: From the above figure

$$\mu = \frac{V_{max} - V_{min}}{V_{max} + V_{min}} = \frac{150-30}{150+30} = \frac{120}{180} = \frac{2}{3}$$

$$A_c[1+\mu] = V_{max}$$

$$A_c\left[1+\frac{2}{3}\right]=150$$

$\therefore A_c$ = 90 (volts)

The required condition is

S(t)=

$$90\left[1+\frac{2}{3}\cos 2\pi f_m t\right]\cos(2\pi f_c t)+A\cos(2\pi f_c t)$$

Should have modulation index of 0.8

$\therefore$

$$(90+A)\left[1+\frac{60}{90+A}\cos 2\pi f_m t\right]\cos 2\pi f_c t$$

$$\therefore \mu=\frac{60}{90+A}$$

$$=0.8$$

Hence A = –15(volts)

$\therefore$ A = 15 $\angle 180°$

Additional amplitude required is 15V and having a phase of 180°.

55. Let f (x, y) = k xy – x^3y – xy^3 for (x, y) $\in R^2$, where 'k' is a real constant. The directional derivative of f(x, y) at the point (1, 2) in the direction of unit vector $\frac{-\vec{i}}{\sqrt{2}}-\frac{\vec{j}}{\sqrt{2}}$ is $\frac{15}{\sqrt{2}}$. Then the value of k is ______.

(A) – 4 (B) 4
(C) 14 (D) 16

Ans: (B)

Sol: (grad f). $\hat{a}=\frac{15}{\sqrt{2}}$

$\{ [ky - 3x^2y - y^3]\ \bar{i} + [kx - x^3 - 3xy^2]\ \bar{j} \}$.

$$\left(\frac{-\bar{i}}{\sqrt{2}}-\frac{\bar{j}}{\sqrt{2}}\right)=\frac{15}{\sqrt{2}}$$

$$\left[(2k-6-8)\bar{i}+(k-1-12)\bar{j}\right].\left[\frac{-\bar{i}}{\sqrt{2}}-\frac{\bar{j}}{\sqrt{2}}\right]$$

$$=\frac{15}{\sqrt{2}}$$

$\therefore$ k = 4

56. In a measurement system the sensor has the first order dynamics is used to measure temperature of a oil bath, the time constant of the sensor is 5sec. If the temperature of the oil bath increased suddenly from 0°C to 70°C the time required for the sensor to sense 70°C is

(A) 5sec (B) 15sec
(C) 20sec (D) 25sec

Ans: (D)

Sol: Time required for the sensor to reach the steady state is 5τ

So, t_s = 5τ = 5 × 5 = 25 sec

57. A 3ϕ, 10 kVA load has a p.f of 0.342 leading. The power is measured by two wattmeter method. The reading of each wattmeter will be?

(A) – 1.732 kW & 7.655 kW
(B) – 1kW & 4.42 kW
(C) – 0.577 kW & 2.55 kW
(D) 1.973 kW & 1.973 Kw

Ans: (B)

Sol: Given power is Apparent power

$$S=\sqrt{3}\,V_L\,I_L$$

$$10\times10^3=\sqrt{3}\,V_L I_L$$

$$V_L I_L=\frac{10\times10^3}{\sqrt{3}}$$

= 5773.5 VA

cosϕ = 0.342

ϕ = 70°

$W_1 = V_L\ I_L \cos(30 + \phi) = -1$ kW

$W_2 = V_L\ I_L \cos(30 - \phi) = 4.42$ kW

58. The state space model of a dynamic system is given below. The system is

$$\dot{X} = \begin{bmatrix} 1 & 1 \\ -2 & -1 \end{bmatrix} X + \begin{bmatrix} 0 \\ 1 \end{bmatrix} U$$

$$Y = \begin{bmatrix} 1 & 0 \end{bmatrix} X$$

Where $X = \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$

(A) Controllable and Observable.
(B) Only controllable
(C) Only observable
(D) Neither controllable nor observable.

Ans: (A)

Sol: $Q_c = [B : AB]$

$$AB = \begin{bmatrix} 1 & 1 \\ -2 & -1 \end{bmatrix}\begin{bmatrix} 0 \\ 1 \end{bmatrix} = \begin{bmatrix} 1 \\ -1 \end{bmatrix}$$

$$Q_c = \begin{bmatrix} 0 & 1 \\ 1 & -1 \end{bmatrix} \Rightarrow |Q_c| = -1$$

The system is said to be controllable if $|Q_c| \neq 0$ where $Q_c = [B : AB]$

$|Q_c| \neq 0 \rightarrow$ so, controllable

$$Q_0 = \begin{bmatrix} C \\ CA \end{bmatrix}$$

$$CA = \begin{bmatrix} 1 & 0 \end{bmatrix}\begin{bmatrix} 1 & 1 \\ -2 & -1 \end{bmatrix}$$

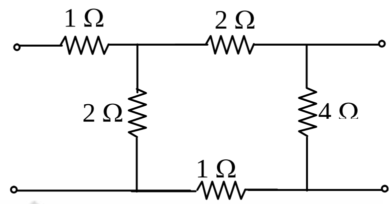
$$= [1 \quad 1]$$

$$Q_0 = \begin{bmatrix} 1 & 0 \\ 1 & 1 \end{bmatrix} \Rightarrow |Q|_0 = 1$$

The system is said to be observable if $|Q_0| \neq 0$ where $Q_0 = \begin{bmatrix} C \\ CA \end{bmatrix}$.

Det $|Q_0| \neq 0 \rightarrow$ so, observable

59. Consider the following network



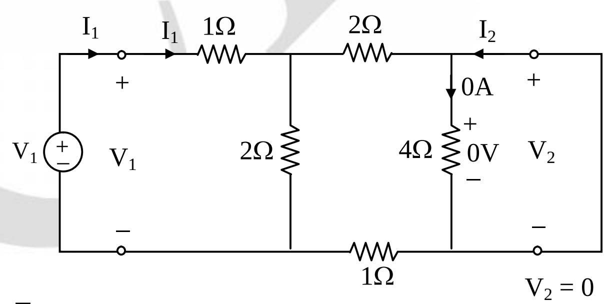
The parameter of Y_{21} in mhos is

(A) $-\frac{2}{11}$ (B) $\frac{2}{11}$

(C) $\frac{5}{11}$ (D) $\frac{2}{5}$

Ans: (A)

Sol: $Y_{21} = \left.\frac{I_2}{V_1}\right|_{V_2 = 0V}$ mhos



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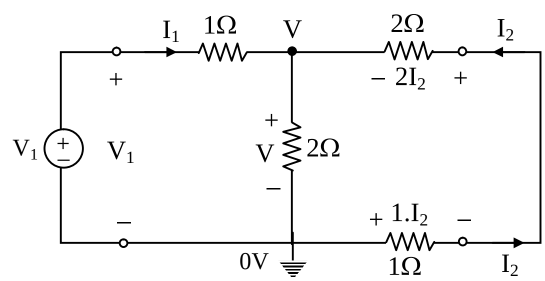


$$\text{Nodal} \Rightarrow \frac{V - V_1}{1} + \frac{V - 0}{2} + \frac{V - 0}{3} = 0$$

$$V_1 = \frac{11V}{6} \quad \text{-------- (1)}$$

BY KVL $\Rightarrow V+2I_2+I_2 = 0$

$\Rightarrow V = -3I_2$ ------- (2)

Eqn (2) in (1) $\Rightarrow V_1 = \frac{11}{6} \times -3I_2$

$$\left.\frac{I_2}{V_1}\right|_{V_2 = 0V} = Y_{21} = \frac{-2}{11} \text{ mhos}$$

60. It is given that $F = F_1.F_2$
Where $F(A,B,C) = \Sigma\, m(0, 2, 6)$;
$F_1(A, B, C) = \Sigma m(0, 2, 3, 6)$
Determine the most simplified function for F_2, in terms of number of literals.

(A) $B\overline{C} + A\overline{B}C$
(B) $\overline{C}$
(C) 1
(D) $A\overline{B} + \overline{B}C + AC$

Ans: (B)

Sol: F_2 must have min terms (0, 2, 6) and may or may not have min terms (1, 4, 5, 7)
i.e. $F_2(A, B, C) = \Sigma m(0, 2, 6) + d(1, 4, 5, 7)$ and its simplified function is

A \ BC	00	01	11	10
0	1	×		1
1	×	×	×	1

$F_2 = \overline{C}$

61. Let $w(y_1, y_2)$ be the wronskian of two linearly independent solutions y_1 and y_2 of the equation, $y'' + p(x)\,y' + Q(x)\,y = 0$. The product of $w(y_1, y_2).p(x) =$

(A) $y_2y_1'' - y_1y_2''$
(B) $y_1y_1' - y_2y_2'$
(C) $y_1y_2'' - y_2'y_1''$
(D) $y_1'y_2' - y_1''y_2''$

Ans: (A)

Sol: $y_1'' + p(x)y_1' + Q(x)y_1 = 0$.......(1)

$y_2'' + p(x)y_2' + Q(x)y_2 = 0$.......(2)

$(1) \times y_2 - (2) \times y_1$

$\Rightarrow p(x)\,(y_1'y_2 - y_1y_2') = y_2''y_1 - y_1''y_2$

$\therefore w(y_1, y_2)\,p(x) = y_1''y_2 - y_2''y_1$

62. A Ruby LASER contains a crystal length 4cm. with a refractive index of 1.78. The peak emission wavelength from the device is 0.55μm. Determine the number of longitudinal modes and their frequency separation.

(A) 1.45×10^5 and 3.75 GHz
(B) 2.6×10^5 and 4.2 GHz
(C) 4.2×10^5 and 2.6GHz
(D) 2.6×10^5 and 2.1GHz

Ans: (D)

Sol: The number of longitudinal modes supported within cavity

$$\eta = \frac{2\mu L}{\lambda} = \frac{2\times1.78\times0.04}{0.55\times10^{-6}} = 2.6\times10^5$$

$$\Delta f = \frac{C}{2\mu L} = \frac{3\times10^8}{2\times1.78\times0.04} = 2.1 \text{ GHz}$$

63. A submarine moves horizontally in sea and its axis is much below the surface of water. A pitot tube just in front of the submarine and along its axis is connected to the limbs of a U-tube containing mercury and a 20cm difference in sea water column is observed. Find the speed of the submarine knowing the density of mercury is 13.6 and that of sea water is 1.026 with respect to fresh water?

(A) 6.26 m/s
(B) 1.979 m/s
(C) 1.94 m/s
(D) 6.26 m^3/s

Ans: (C)

Sol: Sea water deflection = h = 20 cm of sea water

Flow rate $V = C_v\sqrt{2gh}$

$= 0.98\sqrt{2\times 9.8\times 20\times 10^{-2}}$

$= 1.94$ m/s

64. When the mean optical power launched into an 8km length of fiber is 120μW the mean optical power at fiber output is 3μW. Calculate The signal attenuation per km for the fiber and the overall signal attenuation for a 10km optical link using the same fibre with splices at 1km intervals, each giving an attenuation of 1dB.
(A) 16dB, 20dB
(B) 2dB/km, 29dB
(C) 2dB, 29dB/km
(D) 16dB/km, 20dB/km

Ans: (B)

Sol: Attenuation $= 10\log_{10}\frac{P_i}{P_0}$

$$= 10\log_{10}\left(\frac{120\times 10^{-6}}{3\times 10^{-6}}\right) = 16 \text{ dB}$$

(i) $\alpha L = 16$dB

$$\alpha = \frac{16 \text{ dB}}{L} = \frac{16}{8} = 2\text{dB/km}$$

(ii) 10km fiber will give = 20dB ,

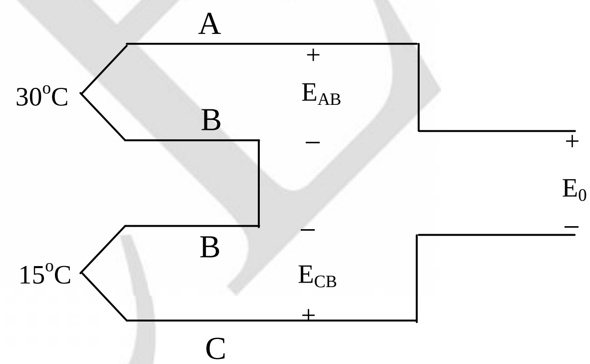
9 splices will give = 9dB

So signal attenuation = 20 + 9 = 29Db

65. A thermocouple is made by using three material A,B,C where B is the intermediate material . Sensitivity of A is + 19μV / °C, sensitivity of B is – 10μV /°C and sensitivity of C is + 20μV/°C. If AB metal junction is heated at 30°C and BC metal junction is heated at 15°C then the output of thermocouple is
(A) 420μV (B) 120μV
(C) 720μV (D) 15μV

Ans: (A)

Sol:



$e_{AB} = (19 + 10)$ μV/°C × 30°C

$= 870$μV

$e_{CB} = 450$μV

now, $E_0 = 870\mu V - 450\mu V$

$= 420$μV